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April 11, 1958

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Dear Sir:

This is the first letter report on Task Order No. T and it summarizes the work done during the period February 27 through March 31, 1958.

During this period, our efforts were directed primarily toward obtaining data on the operation of the generator. On March 12, and again on March 18-20, our representatives visited ERDL at Ft. Belvoir to become more familiar with the problem, and to aid in planning and conducting experiments to obtain temperature data at specified points on the retort of one generator during several cycles of operation. Temperature data from three runs have been received and are being analyzed. The objective of this analysis is to estimate the maximum thermal stresses in the retort during an operational cycle.

Visual observation of two previously used retorts at Ft. Belvoir that had been removed from the generator disclosed the presence of cracks along the weld bead. This weld cracking is probably associated with the effects of weld-metal shrinkage on cooling (during welding of the retort bottom to the shell) superimposed on the thermal stresses in this region. Methods are being considered to eliminate this problem. In some cases, weld-metal

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cracking can be minimized by post heat applied to the weld, thereby effecting a reduction of the cooling rate during manufacture. In other cases, residual weld-metal stresses can be relieved by appropriate stress-relief treatments.

Three rings cut from failed Incoloy retorts were obtained and subjected to metallurgical examination. One ring, identified by us as "A", had been taken from a retort with a drawn-plate-stock bottom. This ring included one major crack running completely around the circumference at a location near the region where the occurrence of high thermal stresses is suspected. Numerous smaller cracks were noted on the inside surface. The principal mechanism underlying the cracking evidenced by this ring is believed to be stress corrosion.

Specimens cut from Rings "B" and "C" showed cast structures, as expected. In both cases, severe shrinkage porosity was in evidence to the extent that about 90 per cent of some of the cross sections examined were quite porous. The blowout in the retort from which Ring "C" had been taken had occurred in such a porous area. Thermal-stress- and stress-corrosion-type cracks on the inside surface ran into these porous areas. The network of cracks coupled with the porosity presented an extremely weak structure.

Certain observations, in addition to the above, were made on the rings of cast and of drawn Incoloy. All were nitrided on their surfaces and in the cracks. Although the nitriding was not regarded as excessive in depth, it would probably result in reduced

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resistance to cracking and to crack propagation because of a considerable reduction in ductility of the material.

Studies are continuing on the three rings. It is hoped that further investigation will disclose pertinent information regarding the relationship among the factors fabrication stresses, thermal stresses, temperature, and environment.

Plans for the next month are to complete the study of the temperature data and, based on the results obtained, to initiate a preliminary stress analysis of the retort directed toward determining the most extreme conditions of thermal stress.

The original appropriation under Task Order No. T was $7,097. As of April 1, 1958, the unexpended balance is approximately $3,750.

Sincerely,

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